OREGON WILD

CLIMATE CONTROL:

How Northwest Old-Growth Forests Can Help Fight Global Warming

JIM MADDRY

"Forest-related mitigation activities can considerably reduce emissions from sources and increase CO_2 removals by sinks at low costs..."

— from the Intergovernmental Panel on Climate Change Fourth Assesment Report (2007)

Oregon Wild has spent over three decades advocating for the protection of old-growth forests. These forests once blanketed the Pacific Northwest, but 100 years of intensive logging has left us with only 10% of our original old growth. We have always known that older forests provide us with clean drinking water, fish and wildlife habitat, and some of our favorite places to recreate. Recently, a growing body of research has shown that the forests we love to fish and camp in can also be part of the solution to the greatest threat the world faces today: global warming. This report is a synthesis of that growing body of science and a call to action to protect the majestic old-growth forests of the Northwest so that they may help slow climate change.

CONTENTS

This report was made possible by the generous support of:

444S Foundation

The Harder Foundation

Wiancko Charitable Foundation

OREGON WILD MARCH 2008

COMPILED BY DOUG HEIKEN
WRITTEN BY DOUG HEIKEN, JONATHAN JELEN AND SEAN STEVENS
DESIGN BY ADRIENNE LEVERETTE
COVER PHOTO BY BOB HOLMSTROM
Big Bottom, Mount Hood National Forest

For the full report and citations, see http://www.oregonwild.org/oregon_forests/global-warming-and-northwest-forests

THE PROBLEM

Global warming has become the most profound issue facing the world today. Humanity's response to climate change will define our times. Over the last few years, the public debate over global warming has shifted from a "fact or fiction" discussion to a dialogue on how best to mitigate impacts and prepare for anticipated changes.

Global temperature and climate are largely determined by the balance of incoming energy from the sun minus outgoing energy that radiates from Earth. The planet's geological history shows cycles of warming and cooling as a result of various factors such as solar radiation and volcanic eruptions that alter the balance between incoming energy and outgoing radiation. Today, the planet is warming rapidly, and scientists have determined that it is very likely caused by human activities that are changing the composition of the earth's atmosphere, effectively thickening a heat-trapping blanket around the Earth.

By burning fossil fuels—coal, oil and natural gas—and through land use activities such as agriculture and logging, we are releasing greenhouse gases to the atmosphere. The major global warming gas is carbon dioxide (CO_2). Right now, CO_2 concentrations in the atmosphere are one-third greater than at any other time in recent geological history and increasing nearly 100 times faster than they did in past climate cycles.

Excessive levels of atmospheric carbon dioxide are causing seriously disruptive climate change. These atmospheric changes are altering ambient temperatures, wind patterns, ocean currents, and precipitation patterns worldwide. As a result, the Earth is experiencing more severe droughts, more extreme storms, and rising sea levels.

Greenhouse gases, such as emissions from coal plants, contribute to global climate change. Many of our daily activities impact the amount of CO_2 in the atmosphere. (USGS, WDOT)

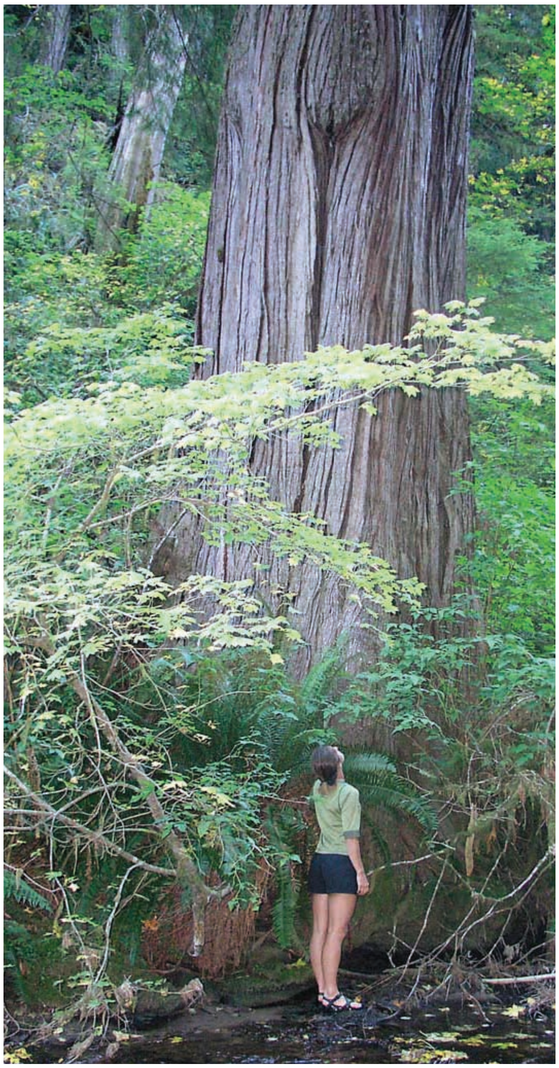
Significant reforms are necessary to address climate change in a comprehensive way, including changes in energy policy, transportation policy, land use, urban design, forestry, agriculture, etc. Some of the current proposed global warming solutions are summarized below.

COMMONLY PROPOSED SOLUTIONS

With the impacts of global warming becoming more and more apparent across the world, the American public has begun to demand strong governmental solutions. As a result, several proposed solutions have come forward:

***Renewable energy*:** Our world energy supply has long been dependent on fossil fuels. Given that emissions from fossil fuels are a significant contributing factor to global warming, one solution to combat climate change is to diversify our energy sources. This could be accomplished by increasing our capacity to draw energy from renewable sources such as wind, solar and geothermal.

Vehicle emission standards and hybrids: With population and industrial growth continuing across the world, emissions from vehicles will play an increasing role in contributing to global warming. One solution to mitigate global warming is to reduce these emissions by implementing new technologies that make cars go farther on a gallon of gas and replacing gasoline with alternatives such as bio-fuels.



JEREMY HALL

What is the potential of old growth to slow global warming?

***Energy efficiency and conservation*:** In addition to exploring alternate sources of energy, another category of proposed solutions involves pushing for a variety of household and commercial products to use less energy while also pushing for conservation of energy through reduced personal use. Meaningfully addressing climate change may require changing the way we approach urban design, food supply, and transportation systems.

THE MISSING LINK IN OUR EFFORTS TO SOLVE GLOBAL WARMING

While many of the proposed solutions above will be important to any nationwide and worldwide effort to slow global warming, they are primarily aimed at reducing the amount of new carbon dioxide that is released into the Earth's atmosphere. What can we do to mitigate the effects that carbon pollution is already having? What role can forests play in storing future CO_2 emissions?

In the past decade, a growing body of research has found that forests have a broad impact on the quantity of greenhouse gases in the Earth's atmosphere. It is becoming clear that an essential strategy to combat global warming will be to unlock the potential of the Earth's natural, living carbon reservoirs: old-growth forests.

In the fall of 2007, scientists and governmental officials from all over the world met in Bali, Indonesia to discuss the ways in which global warming can be mitigated. One of the most impressive new findings highlights the way in which forests, and old-growth forests in particular, can play a role in mitigating climate change through carbon storage.

Forests are the most significant terrestrial stores of living carbon and their destruction and mismanagement over the last century has contributed significantly to the carbon dioxide (CO_2) pollution that threatens our climate. This report will examine two things:

1) The impacts global warming will have on forests and the necessary steps we must take to manage forests to make them more resilient to the anticipated changes brought by climate change;

and

2) Ways in which we can manage forests to help mitigate climate change by allowing forests to fulfill their full potential for storing carbon in living systems.

We have a moral obligation to future generations to pass on a livable planet. In the Northwest this means healthy wildlife populations, thriving salmon runs, clean water and opportunities to enjoy hiking, fishing and camping in unspoiled places. Global warming threatens our ability to maintain sustainable communities. The potential of Northwest forests to mitigate future changes in climate requires us to look seriously at how these natural carbon storage systems can help create a healthy climate future.

What Will Change With A Changing Climate?
The Impacts of Global Warming in the Pacific Northwest

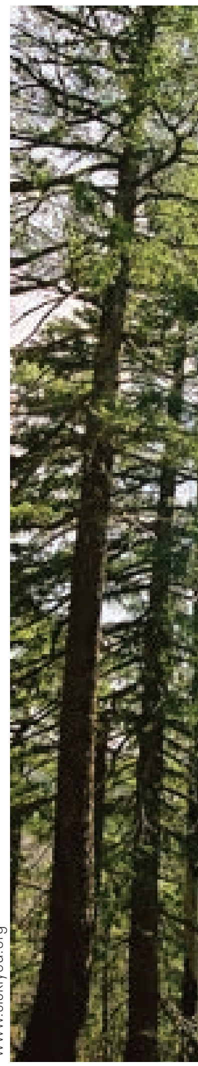
In the last year alone, popular awareness of the Earth's changing climate has grown exponentially. Today, we see elected officials discussing plans to curb carbon emissions, international celebrities urging us to act to slow global warming and large corporations marketing green products of all sorts. With so much media, corporate, and government attention, we have all become more aware of melting ice caps, rising sea levels, and increasing temperatures. But what does global warming mean for Oregon? What will a changing climate alter in the Pacific Northwest?

WHAT TO EXPECT

Have you ever watched your local TV weatherman predict sunny skies only to encounter a downpour the next day? Most people know from experience that predicting the local *weather* is an uncertain science. *Climate* prediction, however, is actually more accurate because the focus is on large-scale trends rather than local details.

With the greenhouse gasses already in the atmosphere, we know that the planet as a whole is almost certain to become warmer on average. However, the effects of climate change will not be uniform around the globe. Significant uncertainty remains about how global trends will express themselves regionally. Future climate in the Pacific Northwest is even more uncertain because of complex topography and uncertain changes in precipitation.

The Pacific Northwest should expect continued climate variability. Existing cycles of cool-wet winters and warm-dry summers will likely continue, though they will be superimposed on a warmer average climate. Both floods and droughts have been part of our past climate and will almost certainly be part of our future. Both floods and drought will likely get worse, but we don't know if these climate extremes will be expressed with more frequency or more intensity, or both. It is reasonable to expect more precipitation, mostly during our existing wet seasons. More of our winter precipitation will fall as rain instead of snow, so storage of water in snow packs will likely decrease (on average). We should expect milder winters, earlier melting of snow packs, earlier spring run-off, longer periods of summer low stream flow, and more drought.



www.siskiyou.org

BREWER'S SPRUCE *(Picea breweriana)* Many plant species could be threatened by the shift in isoclimes that is predicted with a warming planet. Greater mean temperatures may push climate zones northwards and to higher elevations. Species currently inhabiting the niche zones at the extremes of these isoclimes face the greatest risk. One example of a plant species that faces an uncertain future as the climate changes is the Brewer's Spruce. This rare spruce is native to the Klamath Mountains of Southern Oregon and Northern California. In its native setting it is slow growing, often gaining only 20-30 centimeters in height per year.

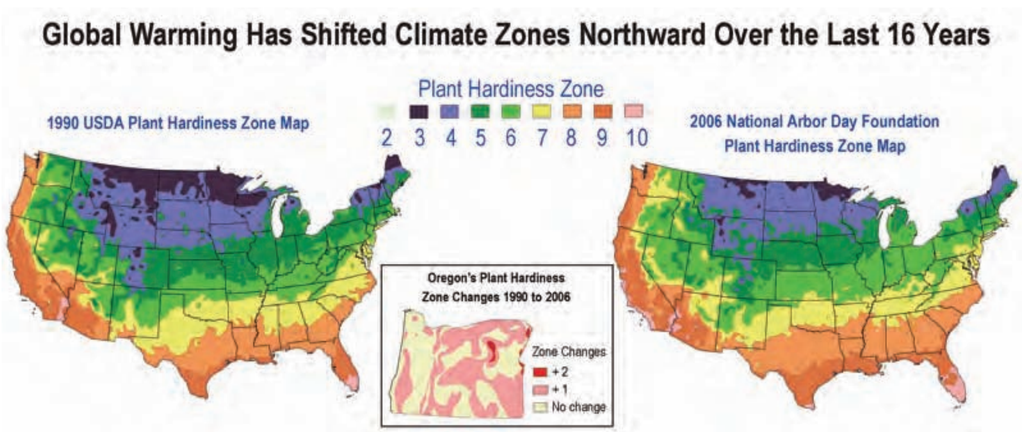
What makes the Brewer's Spruce susceptible to warming temperatures is the climate region it currently inhabits. The Brewer's Spruce typically grows on ridgetops at 5000-7000 feet in elevation. It is best suited to sites with dry summers and heavy winter snows that provide a stable supply of water. These harsh conditions minimize competition from faster growing trees that would otherwise crowd out the Brewer's Spruce.

If the isoclime that the Brewer's Spruce currently inhabits was to shift due to warming temperatures, the changes could lead to increased competition from species more suited to milder climate regimes. The slow growth rate of the Brewer's Spruce also means that the species could potentially have a difficult time migrating to meet the changes global warming may present.

Complicating our ability to predict future impacts of global warming are the many biological, geological and chemical feedback processes that are currently out of equilibrium. These feedback systems can lead to non-linear behavior—a sort of global "piling-on" effect. Due to the non-linear impact of these processes, we should NOT expect climate changes to be slow and predictable. Small changes in CO_2 and global temperature can lead to large and/or rapid changes in climate and ecosystems. Accordingly, the rate of current and future global changes may be unprecedented, chaotic, and highly disruptive for the planet at large and for the Pacific Northwest.

THE BIRDS AND THE BEES, THE FLOWERS AND THE TREES

The climatic patterns of the Pacific Northwest have been in flux for millions of years. Across that time span, tree and plant species, fish and wildlife have all adapted to changes in the makeup of their surrounding ecosystems. As described above, our current human-induced climate changes could have drastic and immediate consequences for Pacific Northwest ecosystems. Some of these potential impacts are outlined below.



TREES

The many tree species native to the Pacific Northwest are dependent on seasonal temperature, precipitation levels, soil quality and relationships with other plants and animals for their continued growth and regeneration. Some trees prefer warmer temperatures and more direct sunlight; others are well suited to alpine regions where winter conditions can be harsh. As the climate changes, the regional distribution of these environmental variables will be altered.

One macro-level consequence to expect as a result of global warming is shifting "isoclimes" or plant hardiness zones *(see above)*. Isoclimes are zones of similar climate such as the dry Ponderosa pine forests of Eastern Oregon, or the wet, Sitka spruce forests of the Oregon Coast Range. As temperatures rise, forest communities will shift toward the poles and toward higher elevations.

One danger of shifting isoclimes is that the climate may change faster than a tree's natural capacity to migrate. In other words, the climate may move, but the trees won't be able to move with it. Also, forests containing multiple species of trees and other wildlife are not expected to shift together as intact communities because of the differing capacity of each species for dispersal, migration, establishment, and tolerance of climate change.

There are also many specific and significant feedbacks between climate and trees:

- Increasing temperatures can lead to longer growing seasons and more plant growth.
- Temperature increases may lead to earlier drying of fuels and the likelihood of longer fire seasons.
- Milder winters (more frost-free days) and warmer summers will allow insect populations to increase.
- Warmer temperatures will increase rates of respiration and decomposition, releasing CO_2 to the atmosphere.
- Higher temperatures will increase evaporative losses from soils and increase transpiration from plants, likely increasing seasonal drought stress.
- Increased CO_2 levels may increase the proliferation of shade tolerant trees that provide ladder fuel for fires.

The relationship between carbon and trees is not a one-way street. As the climate changes, trees will continue to "breathe" both in and out. During the day trees engage in photosynthesis that captures CO_2 to build sugars and release oxygen. Trees also engage in respiration (like animals), a process that uses some of the sugars produced during photosynthesis, consumes oxygen, and returns CO_2 to the atmosphere. Plant growth is a result of a net imbalance between photosynthesis and respiration. In trees the extra carbon is turned into cellulose and wood. Studies have revealed that elevated CO_2 may increase tree growth at the expense of other aspects of plant health and could degrade the quality of the resulting plant material as food and fiber.

FISH AND WILDLIFE

Fish and wildlife that call the forest home will also feel the impacts of a changing climate. Warming temperatures and altered habitat will effect animal populations in various ways.

Some biological effects of climate change can already be seen. There is evidence that some trees are leafing out earlier and flowers are blooming earlier. Also, some birds are migrating sooner in the year, and seasonal peaks in some insect populations are occurring ahead of schedule.

As isoclimes shift and species change their seasonal behavior, forest community composition will likely change. These changes might include the disruption of co-evolved relationships between predators and their prey, plants and their pollinators, and migration timing and flowering.

Expected decreases in summer stream flow and increases in stream temperatures will place additional stress on cold-water fish such as the Northwest's famed salmon and trout. Forests may consequently be deprived of large quantities of marine-derived nutrients that for millennia have been conveyed by salmon from the ocean to continental ecosystems.

FOREST ECOSYSTEMS

When the parts begin to change, the whole system transforms. A warming climate will not only impact the plants, trees, fish and wildlife that make up our forests, but will alter the overarching ecosystem as well.

Examining something as complex and diverse as a forest ecosystem, it is difficult to predict the large-scale changes that could occur due to climate change.

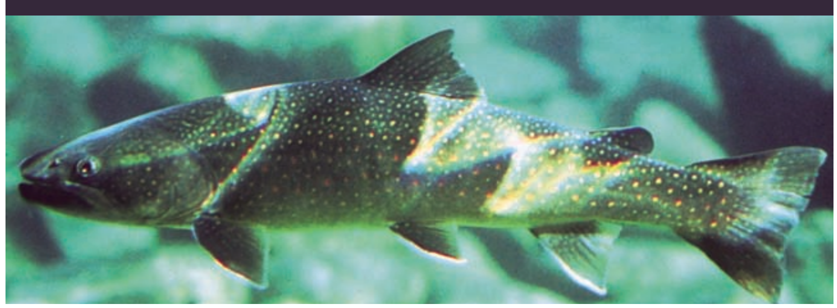
Even with that uncertainty, the following trends in forest ecosystems should be expected as a result of climate change:

- Forest disturbances such as fire and defoliating insects will likely increase.
- Other disturbances such as flooding, and wind and storm damage will also likely increase.
- During the tumultuous period of shifting biomes, opportunistic "weedy" species will readily replace native species that are displaced by climate change. Forests will likely become simplified due to the ascendancy of these weedy species.
- The movement of existing forest types northward and toward higher elevations will likely cause extirpation of species where natural or human-induced habitat bottlenecks are encountered.

BULL TROUT *(Salvelinus confluentus)* once inhabited streams and lakes as far north as Alaska and as far south as Nevada. Today, due in large part to land management practices that have adversely affected prime bull trout habitat, that historic range has shrunk to parts of Oregon, Washington, Idaho and Montana. Climate change poses additional risks to the future viability of the species.

Bull trout are a member of the salmon family and require similar habitat for different stages of their life cycle. Specifically, bull trout require especially clean and cold water to spawn. Research has shown that spawning areas are often found near cold-water springs or groundwater sources that drop water temperatures below 48 degrees Fahrenheit.

Rising atmospheric temperatures are expected to both increase overall water temperatures and reduce snow pack and stream flow. These combined effects from global warming on stream and lake temperatures could potentially diminish the already limited distribution of bull trout spawning habitat.



USFWS

Some of the changes in forest disturbance regimes described above may overshadow the direct physiological effects of climate change on plants and trees. Disturbances such as wildfire, flooding, wind and storm damage, insect damage, and invasive species typically disrupt photosynthesis and favor respiration/decomposition processes, thereby releasing CO_2. This means that the changes in forest ecosystems created by global warming may work to exacerbate carbon pollution leading to more climate change.

The Current Future of NW Forests: Will the Forests of the Future Become Carbon Sources or Carbon Sinks?

The preceding section analyzed the varying impacts on Northwest forests that we can expect as climate change continues to alter ecosystems. As we begin to better understand the consequences of global warming, two important questions come to the forefront:

- Are Northwest forests more likely to store more carbon or release existing carbon under a changing climate?

  and

- What can we do to improve the chances that forests will play a beneficial role in the effort to slow global warming?

The Delicate Carbon Dance

Just to put the global terrestrial biosphere in perspective, there is about ten times more carbon contained in all land plants (plus the soil they grow on) than all the "extra" anthropogenic carbon currently in the atmosphere. Most of the terrestrial carbon is contained in forests many of which have been significantly depleted by mismanagement. Our remaining forests are part of a delicate interplay between plant life and the chemical composition of the surrounding atmosphere.

> If we carefully conserve our forests, they can play a substantial role in mitigating our current carbon predicament.

Source or Sink? Good News and Bad News

Research has suggested that a warming climate could lead to a good news/bad news situation in the interplay between CO_2 uptake from photosynthesis and CO_2 emissions from respiration and decomposition. Northwest forests may see near-term benefits from higher temperatures followed by long-term negative consequences.

The good news is that slight to moderate warming is expected to increase our forests' ability to store carbon through increased growth and geographic expansion of trees into new territory. Pacific Northwest forests could become significant carbon sinks and help mitigate climate change if growing conditions remain favorable and disturbances like fire do not significantly increase.

The bad news is that there is likely a warming *threshold* above which forests will decline due to drought stress and increased disturbances. Drought stress limits the potential photosynthetic benefits of longer growing seasons and CO_2 enrichment. Increasing temperature also increases rates of respiration and decomposition. Under a future climate scenario like this, Northwest forests could wither, recede geographically, and become a significant net carbon source. The IPCC tells us that some warming has already occurred and that existing levels of CO_2 already commit us to some additional warming. There is considerable uncertainty about when different forests may cross the threshold from sink to source. It is conceivable that moist forests west of the Cascades might persist as net carbon sinks, while the dryer forests east of the Cascades might become net sources sooner.

The Bottom Line

If we carefully conserve our forests, they can play a substantial role in mitigating our current carbon predicament. Even if forests shift from becoming a carbon sink to a carbon source, we could make the source worse through mismanagement of forests by accelerating the release of forest carbon to the atmosphere as we have done for the last 100 years. If the emissions that result from economic exploitation of forests are added to anticipated climate stresses, carbon emissions will increase on a greater scale than if we commit to conserving our forests.

Northwest Forests, Global Warming Warriors: Capturing Carbon from Canopy to Ground Cover

MYTH Fast-growing young forests absorb more carbon and are better for the climate than slow-growing old forests.

FACT Old forests store far more carbon than young forests. Most old forests are still growing and absorbing carbon. Mature forests cannot be converted into young forests without losing most of the carbon to the atmosphere.

It is commonly believed that fast-growing young forests are better carbon stores than slow-growing old forests. The timber industry would have us believe that once a tree reaches maturity and begins to grow more slowly, we need to cut it down and replace it with another fast-growing young tree. In fact, this characterization of the relationship between forest age and carbon storage is inaccurate and incomplete.

Scientists have discovered that old forests continue to absorb CO_2 even after tree growth appears to have slowed. This may be explained in part by the fact that old-growth trees send large amounts of carbon into the soil to support belowground ecosystems that help sustain them. One example of an interdependent relationship built on carbon transfer is older trees sharing carbohydrates with fungi in exchange for water and other nutrients.

To understand the fate of carbon in old forests we need to look beyond the big trees. Traditional forestry tools place a disproportionate focus on “crop” trees that are of interest to the timber industry. This perspective fails to accurately describe the flow of carbon through complete ecosystems, including: dominant trees, minor tree species, shrubs and forbs, dead wood and snags, soil organic matter, and other wildlife. Old forest ecosystems continue to absorb and store carbon because they harbor a diversity of organisms and because they continually recruit new life to replace declining trees.

Another fallacy is that young trees can replace old forests without losing most of the stored carbon to the atmosphere. An honest accounting reveals that logging releases vast amounts of carbon that is not captured and stored in wood products. Young forests continue to release carbon for decades after harvest.

DOUG HEIKEN

FOREST FOCUS
Restoring the Carbon Capacity: The Siuslaw Model

In the 1990s, Siuslaw National Forest Supervisor Jim Furnish came to an important realization. The public no longer supported logging of old-growth trees on National Forest land. On the Siuslaw, there wasn’t much old growth left to cut anyway. In the latter half of the 20th century, large-scale clear-cut logging had decimated much of the 630,000-acre strip of forest along the west flank of the Oregon Coast range.

Beginning in the mid-1990s, Furnish led a turnaround inside the Siuslaw National Forest. Guided by the newly minted Northwest Forest Plan and using newly granted “stewardship contracting” authority, Siuslaw forest planners met with diverse stakeholders and began planning projects geared towards restoration rather than liquidation of old growth.

Fast-forward ten years and the Siuslaw remains a model for forest restoration and stakeholder collaboration. Rather than logging old growth, planners now design restoration-thinning sales with the aim of restoring old-growth characteristics to previously clear-cut, densely packed tree plantations. By responding to public desires, Siuslaw timber sales have managed to avoid past controversy. In fact, there hasn’t been a big fight over a Siuslaw timber sale in over a decade.

This collaborative work to restore former clear-cuts to natural, old-growth forests has also benefited the fight against global warming. Tightly packed, single species tree plantations are prone to disease and fire, providing the potential for disturbances that could release CO_2. By restoring old-growth characteristics to the Siuslaw forest, carbon storage will be more abundant and efficient and the forest will be more resilient to fire.

NORTHWEST FORESTS: CARBON STORAGE SUPERSTARS

MYTH Forests outside the tropics are unimportant because they do not contribute significantly to global carbon storage.

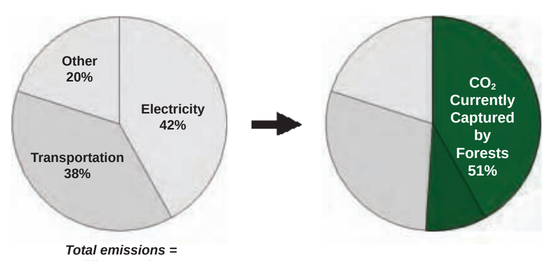
FACT Pacific Northwest temperate rainforests can attain the greatest biomass per acre of any ecosystem on earth. Temperate and boreal forests are very extensive and currently serve as net carbon sinks.

There appears to be broad recognition that tropical forests are important and deserving of conservation. Unfortunately, many have taken this justified position to advocate the unfounded claim that forests outside the tropics are not important and do not contribute significantly to global carbon storage.

Tropical forests clearly deserve our attention. Tropical forests enjoy stable and continuous growing conditions that allow them to develop large amounts of carbon biomass and tremendous biodiversity. Tragically, tropical forests are experiencing alarming rates of forest loss due to population pressures and economic forces, while temperate forests are expanding. In developing countries, tropical forests are too often used for firewood, resulting in the immediate release of stored carbon.

In the Pacific Northwest, our forested land is dominated by "temperate rainforests" that compare favorably to tropical forests in relation to their importance in combating global warming. The Northwest's low-elevation old-growth forests have high biodiversity, long growing seasons and mild winters due to the maritime influence of the Pacific Ocean. These characteristics allow Northwest forests to store as much or more carbon per acre as tropical forests. When the large geographic distribution of temperate and boreal forests is taken into account—especially in North America and Eurasia—the carbon potential of these forests is impressive.

Oregon CO_2 Emissions Captured by Forests



Oregon's forests alone currently capture half of the total greenhouse gas emissions in the state. If given proper protections, Oregon's forests could potentially sequester much more. DATA FROM OREGON DEPT OF ENERGY AND D.P. TURNER, ET AL 2007

The maritime climate of the Pacific Northwest, with its mild winters, long growing seasons, and relatively long periods between severe fires, provides very good conditions for growing forests

BOB HOLMSTROM

FOREST FOCUS
Big Bottom

Located along the Clackamas River in the Mount Hood National Forest, the Big Bottom Roadless Area boasts one of the most impressive stands of old growth anywhere in the Northwest. "Big" is the operative word here, where huge Douglas and grand firs dominate the forest and visitors find themselves among 1,000-year-old cedars.

While Big Bottom is a relatively small area, comprised of just 1,153 acres, it is an incredibly biologically productive flat-forested valley. Area streams provide immensely productive salmon and steelhead habitat and the enormous canopies of old-growth Douglas firs, grand firs, and western red cedars provide layered protection during winter snows for deer and elk.

Big Bottom was originally slated for an old-growth timber sale in the late 1980s. Luckily, the area was spared, and Big Bottom has been featured in various Wilderness proposals encompassing portions of the Mount Hood National Forest.

Though bordered by a highway on one side and areas that have sustained heavy logging on the other, Big Bottom's old-growth characteristics are incredibly important to the carbon storage capabilities of northwest Oregon. Being one of the most ancient old-growth areas within close proximity to Portland—Oregon's largest population center—the current and potential carbon storage of this native forest is especially consequential.

with large, long-lived trees. Researchers recently measured carbon storage in several different types of old-growth forests in Oregon and Washington, both east and west of the Cascades. They found that carbon densities measured in Pacific Northwest old-growth forests were higher than any other type of vegetation anywhere in the world. Additionally, the research showed that, compared to other regions, Northwest forests store more carbon in trees relative to soil. This research suggests that if we manage our forests for old growth conditions, Northwest forests show a great potential for storing additional carbon in large old trees.

LOGGING, FOREST PRODUCTS AND CARBON RELEASE

MYTH It's better to store carbon in wood products than in forests.

FACT Carbon is stored more securely in long-lived forests than in short-lived wood products.

Some argue that logging is helpful because carbon is sequestered in wood products. They point to carbon stored for hundreds of years in Elizabethan furniture and Hindu temples. Of course there is a grain of truth to the assertion that wood products store carbon, but the full picture requires that we account for the fate of all the carbon in logged forests, not just the small fraction that ends up as wood products. It turns out that well-conserved forests store carbon more securely than the average forest converted to wood products.

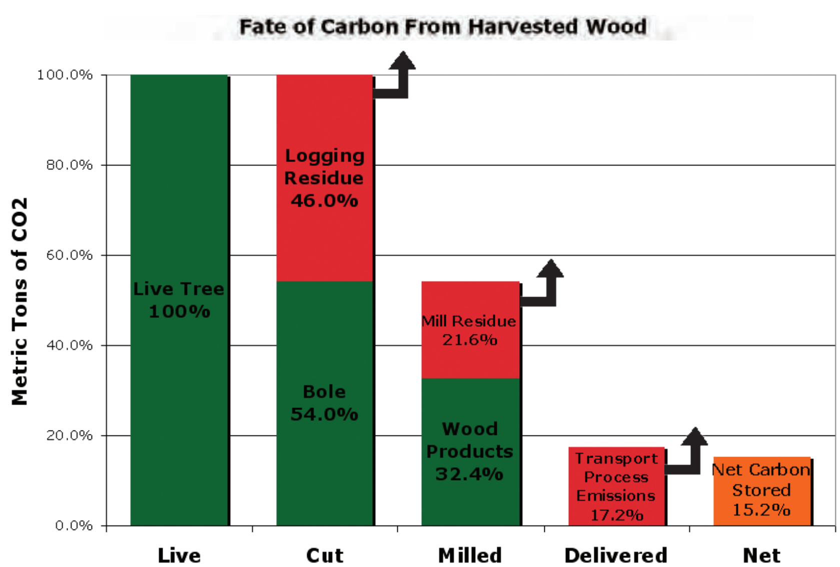
First, only a small fraction of the carbon removed from logged forests ends up stored as durable goods and buildings. Most of the carbon ends up in the atmosphere after spending a short time as slash, sawdust, waste/trim, hog fuel, and non-durable goods like paper and pallets. Second, wood products have short "life spans" compared to forests that are well protected from logging. Most wood products are essentially *disposable.* Wood products that can reasonably be considered *durable* (e.g. buildings) may in fact be less durable than the wood retained safely inside old-growth trees that can live to be hundreds of years old.

Not surprisingly, logging accelerates the transfer of carbon to the atmosphere by killing trees that would otherwise continue to capture and store carbon through photosynthesis and growth. Killing trees also stops them from pumping carbon into the soil where much of the carbon in forests is stored. Halting the flow of carbohydrates from trees into the soil food web initiates a cascade of effects resulting in the death and decay of many soil organisms and the release of soil carbon to the atmosphere.

www.kswild.org

Slash burns that follow clear-cut logging emit large amounts of carbon into the atmosphere.

Logging also accelerates the rate of decomposition of wood via several mechanisms. By removing the forest canopy and exposing the soil to more sunlight, logging raises soil temperature, increasing bacterial activity and the rate of decay. Logging also physically fragments woody material in the forest thereby decreasing the average piece size and increasing the surface area exposed to



Forest products retain only 15% of the initial carbon stored in a live tree. The rest is released to the atmosphere. COURTESY THE WILDERNESS SOCIETY, DATA FROM SMITH, ET AL 2006 AND GROWER, ET AL 2006 microbial decomposition. Finally, logging debris is often burned on site or as part of an industrial process, releasing carbon to the atmosphere.

Logging can also increase the risk of disturbances that emit carbon. Logging may increase wind damage by creating exposed edges between logged and unlogged forest and by increasing wind speeds within forest stands. There are multiple ways logging can increase wildfire hazard by making the stand hotter, dryer, and windier. Logging practices move the most flammable small fuels from the forest canopy to the forest floor where they are more available for combustion (i.e., logging slash). Replanting practices create a dense growth of fire-prone young trees with interlocking branches close to the ground. Logging roads also increase the risk of human-caused fire ignitions and can spread tree diseases like Port Orford cedar root disease that kill trees and release carbon.

FOREST FOCUS
Mismanagement on the Middle Santiam

The Middle Fork Santiam River forms in the foothills of the western Cascades. After descending from the Cascades, the river passes through the Middle Santiam Wilderness, an area protected by law in 1984 as a place to be left free of development and preserved for future generations.

From this untrammeled landscape, the river turns to the southwest, heading towards Sweet Home. In 1955, this area was much like the Wilderness it now borders (see photo), blanketed in Douglas fir, hemlock, and western redcedar. These healthy stands of old-growth forest helped capture much of the carbon pollution that Oregon's growing mid-century population was producing.

Now, after 50 years of management by private logging interests, the character of the land is much different. If one were to float down the river today, clear-cuts would dominate the horizon.

Aside from tarnishing the beauty of the land, the intensive logging has released thousands of tons of carbon to the atmosphere and diminished the carbon storage potential of the area. These clear-cuts have occurred over the course of just a few decades, but research shows that it will take more than 100 years to rebuild pre-logging carbon stores.

NATIVE FOREST COUNCIL

Scientists estimate that 45% of all the carbon transferred to the atmosphere by humans has been released due to forest exploitation. Though forest releases are less than total emissions from all uses of fossil fuels, many would be surprised to find that, in recent decades, CO_2 emissions resulting from human-induced changes to forests exceed CO_2 emissions from the transportation sector. After logging an old-growth forest, the site remains a net source of carbon for more than 20 years, and depending on conditions, logged sites may not rebuild pre-logging carbon stores for a century or more. As a result of widespread clear-cutting and aggressive slash burning, the Pacific Northwest has contributed more than 1.5 billion metric tons of carbon to the atmosphere.

FIRE AND GLOBAL WARMING

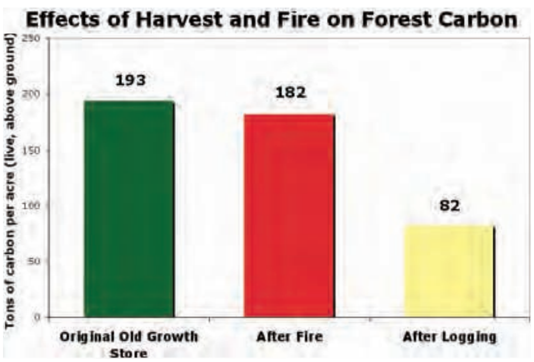
MYTH Forests are not good places to store carbon because forest fires release stored carbon through combustion.

FACT Fire is an essential ecological process that helps forests stay healthy. Carbon release from logging is far greater than release through natural fire.

Forest fires have received a lot of negative attention in recent years. Many believe that forests are not good places to store carbon because forest fires release carbon. Certainly, forest fires do release CO_2, but only a small fraction of the total forest biomass is lost to the atmosphere. Due to the incomplete combustion of large wood, 70-80 percent of the carbon in tree stems remains after forest fires and, globally, 23 times more carbon is captured by photosynthesis than is emitted by fires.

Even after a forest fire, most of the dead wood remains in the forest and contributes to carbon sequestration. Taking a long-term view, forest fires represent a temporary localized dip in the landscape carbon pool that should eventually return to high levels with proper management. So-called "salvage logging" would tend to exacerbate the carbon released by the fire because (a) salvage logging disturbs soils causing the release of soil carbon, (b) salvage logging converts the largest, longest-lasting logs into short-lived wood products, and (c) salvage logging reduces the piece-size of the remaining material, resulting in higher rates of decomposition.

In managing natural ecosystems for carbon storage we cannot avoid the fundamentally dynamic nature of forests. Fire is an unavoidable and even desirable part of life in western forests and we must stop fighting a losing battle against the inevitable. Most western forests are in some ways *dependent* upon disturbances such as fire, and past fire suppression has exacerbated rather than solved the problem of fire. Fires can even help store carbon by increasing the vigor of large trees by killing competing small trees.



Logging releases far more carbon pollution than forest fire.
DATA FROM WAYBURN, ET AL 2000

We should maintain healthy forests by allowing natural disturbance processes like fire to operate and expect forest carbon stores to ebb and flow. We should also allow forests to grow for long periods (and capture lots of carbon) in between these natural disturbances. Taking a long-term and landscape view we can *optimize* carbon storage at any given point in space and time and *maximize* carbon storage over large landscapes and long time frames.

It may be necessary to reduce fuels in forests that are suffering from fire exclusion, but this must be done in a strategic and limited way that protects all large fire-resilient trees and spatially disconnects large expanses of excessive fuels while retaining as much biomass as sustainably possible. Current enthusiasm for wide-scale fuel reduction must be tempered with a realization that removing too much fuel makes forests hotter, dryer, and windier which increases fire hazard and increases decomposition rates, both of which conflict with carbon storage and other objectives.

OREGON WILD

FOREST FOCUS
Big Efforts on the East Side

Fire is a natural part of the dry forests of eastern Oregon. Low-intensity burns once swept through these areas regularly, clearing out dead limbs and underbrush, while leaving most mature and old-growth trees untouched. This natural fire regime maintained the ability of old-growth forests to act as the lungs of the Northwest, releasing oxygen, taking in carbon pollution and moderating the climate.

Sadly, for a century, the U.S. Forest Service, Bureau of Land Management and state agencies have tried to stop all fires in eastside forests. This has led to uncharacteristic fires that put homes, communities and some old-growth forests at risk, while adding carbon to the atmosphere. These older trees should be providing us with a natural buffer against carbon pollution but, due to mismanagement, these forests are not meeting their full potential.

That is exactly why Oregon Wild is teaming with the Forest Service, local residents, other conservationists and staff from The Warm Springs Tribes to carry out a conservation thinning project on 800 acres of dry forest that has been degraded by past logging and fire suppression.

The project is located near Black Butte Ranch and Sisters on the east side of the Cascades. When the project is complete, the restored forest will feature fire-resistant old growth that will both reduce the likelihood of carbon emissions from fire and increase the capacity of the forest to store CO_2.

After fire, carbon in remaining large trees should be retained on site and the recovering forest should be allowed to grow into a mature and old-growth condition. Aggressive replanting after fire is unsupported because it establishes a dense fuel-laden condition that is susceptible to drought and is soon ripe for another fire. Natural regeneration of forests leads to more diverse and less dense forests, resulting in habitat diversity and resiliency to future hazards. Thus, a naturally regenerated forest is an asset in slowing climate change.

BEYOND CARBON: THE COMPLIMENTARY BENEFITS OF OLD GROWTH CARBON STORAGE

Carbon storage in forests requires that we allow forests to grow for long periods without significant disturbance. This is consistent with recommendations for realizing myriad other benefits from forests.

CLOCKWISE L-R: CHANDRA LEGUE, OREGON WILD, CHANDRA LEGUE, STEVE KINGSFORD-SMITH

Complementary benefits of protecting old growth for carbon storage: clean drinking water, habitat for rare species and taking part in a great American pastime.

WATER QUALITY Logging and roads have caused substantial damage to water quality affecting thousands of miles of streams in the Pacific Northwest. Allowing forests to grow to store carbon will reduce canopy removal and increase shade needed to keep streams cold for salmon and trout. Allowing forests to grow will also reduce soil disturbance, erosion, and sedimentation.

FLOOD CONTROL Abundant mature forest cover help intercept, capture, store, and slowly release water during storm events. Watersheds that are intensively managed for logging tend to accelerate storm run-off due to soil compaction and hydrologic connection of road drainage to streams. Allowing forests to grow will improve canopy interception of storms, improve soil porosity, and reduce road impacts, thus helping to mitigate storm impacts.

HABITAT Fish and wildlife use a variety of habitats representing the range of forest successional stages from young to old. Past management has created an over-abundance of young simplified forests and a deficit of complex older forests. This unnatural mix of forests is not how fish and wildlife populations evolved. Allowing forests to grow and store carbon will help restore a more natural mix of habitat types by converting over-represented young forests to make up the deficit of older forests, which is just what wildlife populations need.

SOIL CONSERVATION Soil is a vital living component of the forest ecosystem that contains a complex web of thousands of interacting species that depend on nutrient inputs from the vegetation and wildlife above. Soil quality is degraded by the removal of live and dead vegetation. Soil is also degraded by compaction, displacement, and rutting caused when heavy machinery physically harms soil structure, killing soil organisms, and depriving them of oxygen. Allowing trees to grow and store carbon will help maintain healthy vegetation cover, feeding the belowground ecosystem and limiting soil disturbance and compaction.

NUTRIENT CYCLING Healthy forests not only capture, store and release water but also the nutrients that sustain current and future forests. Also, after fire, dead trees act as sponges absorbing nutrients that would otherwise leak from the site. Those nutrients remain on site and are slowly released over time through the action of microorganisms. Allowing forests to grow and store carbon enhances this important ecosystem service provided by healthy and diverse forests.

QUALITY OF LIFE AND RECREATION The Northwest enjoys a high quality of life that attracts well-educated and highly motivated people from all over the world who enjoy a healthy environment, beautiful landscapes, and abundant outdoor recreation opportunities. These same natural amenities draw businesses to the region and contribute to local economies. Allowing forests to grow and store carbon also contributes to quality of life and drives one of the most important economic engines in the Northwest.

In this report, we have seen that Pacific Northwest forests are a globally significant carbon storehouse that should be nurtured and conserved to help keep global warming gases out of the atmosphere.

The objectives of forest management with respect to mitigating climate change should be a two-fold effort to protect forests and restore forests:

- Protecting forests will minimize the release of additional forest carbon into the atmosphere. The best way to retain carbon in existing forests is to protect mature and old-growth forests and roadless areas, which represent significant carbon storehouses.

- Restoring forests will rebuild depleted carbon stores within landscapes affected by logging. Probably the best way to rebuild forest carbon stores is to give forests plenty of time to regrow after logging or fire so disturbed forests may again become mature and old-growth forests.

1. PROTECTING OLD GROWTH

There are about 8.5 million acres of mature and old-growth forests in western Oregon, western Washington and northwestern California. All mature and old-growth forests in the Pacific Northwest should be protected to maintain their ability to effectively store carbon and slow global warming.

In the drier forests east of the Cascades, old-growth forests have not been accurately inventoried but are recognized to be severely depleted and some are at risk of uncharacteristic fire. Protecting old forests in areas with frequent fire regimes will require a prohibition on logging the few remaining large trees, and careful and strategic removal of small trees that have encroached due to fire exclusion.

2. RESTORING YOUNG FORESTS

There are hundreds of thousands of acres of previously logged younger forests in Oregon that should be carefully restored to a mature and old-growth condition to enhance carbon storage. Some areas will be restored through natural processes and some areas must be restored by thinning that seeks to maximize old-growth potential and minimize damage from logging.

3. MAKING FORESTS RESILIENT

To increase the chances that we will continue to enjoy the diverse benefits we receive from Northwest forests, we must maintain and enhance their ability to respond to change. We can do this by maintaining biodiversity in all its dimensions. This is critical, because genetic diversity is like a library of biological possibilities that have worked well during past climate variability, representing the sum of "tools" available to prepare forests for the future.

4. MARKET SOLUTIONS

Given that more than half of the productive capacity of Oregon's forest land base is owned or controlled by private interests, it is equally important to increase carbon storage on non-federal lands. However, non-federal forest owners have different, often purely economic, objectives for those forests. Adjustments to the free market may be necessary to create incentives for carbon storage on non-federal lands. Market corrections that reward forest owners for conservation and carbon storage help ensure that the carbon consequences and climate consequences of forestry and other economic activities are reflected in the price of wood and other products.

5. BETTER PRACTICES ON PRIVATE LANDS

Where logging is expected to continue, scientists recommend that carbon emissions can be reduced and carbon storage enhanced if forest managers:

- Allow trees to grow much longer between harvests (i.e., longer rotations),

- Retain more live trees on every acre during harvest (i.e., thin instead of clear-cut),

- Retain more dead wood after harvest (e.g. retain snags and down logs, practice less intensive slash disposal and site preparation), and

- Take steps to reduce road systems and prevent soil erosion, which helps store more carbon in forest soils.

CLOCKWISE L-R: JIM BERRY, OREGON WILD, LARRY OLSON, LOIS EAGLETON

OREGON WILD

For over 30 years, Oregon Wild has worked to protect Oregon's wildlands, wildlife and wild waters as an enduring legacy for future generations. We keep Oregon a special place to live, work and raise a family.